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MAGIC gamma-ray and multi-frequency observations of flat spectrum radio quasar PKS 1510-089 in early 2012

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Abstract

© 2014 ESO. Aims. Amongst more than fifty blazars detected in very high energy (VHE, E> 100 GeV) γ rays, only three belong to the subclass of flat spectrum radio quasars (FSRQs). The detection of FSRQs in the VHE range is challenging, mainly because of their soft spectra in the GeV-TeV regime. MAGIC observed PKS 1510-089 (z = 0.36) starting 2012 February 3 until April 3 during a high activity state in the high energy (HE, E> 100 MeV) γ-ray band observed by AGILE and Fermi. MAGIC observations result in the detection of a source with significance of 6.0 standard deviations (σ). We study the multi-frequency behaviour of the source at the epoch of MAGIC observation, collecting quasi-simultaneous data at radio and optical (GASP-WEBT and F-Gamma collaborations, REM, Steward, Perkins, Liverpool, OVRO, and VLBA telescopes), X-ray (Swift satellite), and HE γ-ray frequencies. Methods. We study the VHE γ-ray emission, together with the multi-frequency light curves, 43 GHz radio maps, and spectral energy distribution (SED) of the source. The quasi-simultaneous multi-frequency SED from the millimetre radio band to VHE γ rays is modelled with a one-zone inverse Compton model. We study two different origins of the seed photons for the inverse Compton scattering, namely the infrared torus and a slow sheath surrounding the jet around the Very Long Baseline Array (VLBA) core. Results. We find that the VHE γ-ray emission detected from PKS 1510-089 in 2012 February-April agrees with the previous VHE observations of the source from 2009 March-April. We find no statistically significant variability during the MAGIC observations on daily, weekly, or monthly time scales, while the other two known VHE FSRQs (3C 279 and PKS 1222+216) have shown daily scale to sub-hour variability. The γ-ray SED combining AGILE, Fermi and MAGIC data joins smoothly and shows no hint of a break. The multi-frequency light curves suggest a common origin for the millimetre radio and HE γ-ray emission, and the HE γ-ray flaring starts when the new component is ejected from the 43 GHz VLBA core and the studied SED models fit the data well. However, the fast HE γ-ray variability requires that within the modelled large emitting region, more

compact regions must exist. We suggest that these observed signatures would be most naturally explained by a turbulent plasma flowing at a relativistic speed down the jet and crossing a standing conical shock.

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Keywords

Galaxies: active, Galaxies: jets, Gamma rays: galaxies, Quasars: individual: PKS 1510-089